Wind Integration Analysis for Iteration 2 Studies

Impacts to the Federal Systems Ability to Carry Reserves

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Outline

- What are Balancing Reserves
- Overview of the Analysis
- Evaluation criteria
- Analysis results
- Summary

What are Reserves?

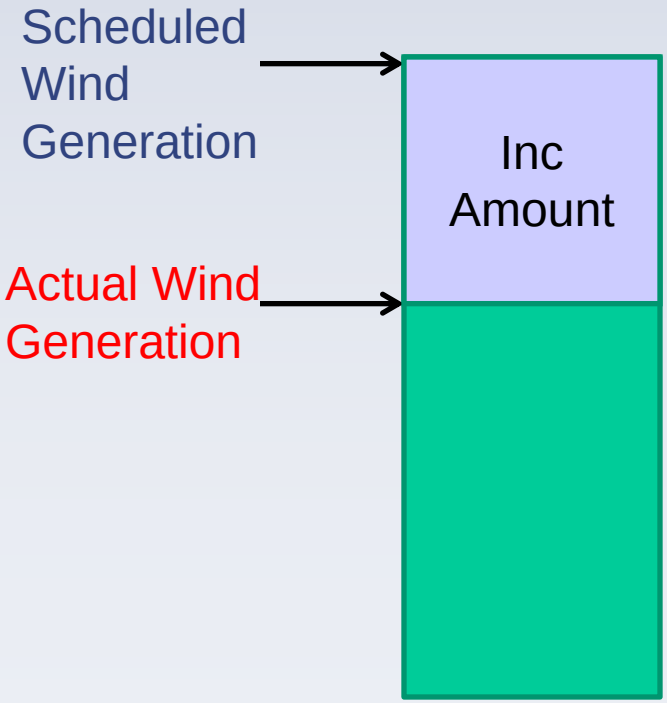
- In a power system, generation must always equal energy demand or load
- The system must be able to balance the moment-to-moment variations between loads and generation by having the ability to increase or decrease generation
- This is done with Reserves

1. Contingency Reserves
    - Reserves, or idle generators, to account for the loss of a major resource
2. Balancing Reserves
    - Reserves to balance moment-to-moment variation in loads/generation as well as the difference between actual generation and schedules
    - This analysis will focus on reserves needed to account for actual and scheduled generation

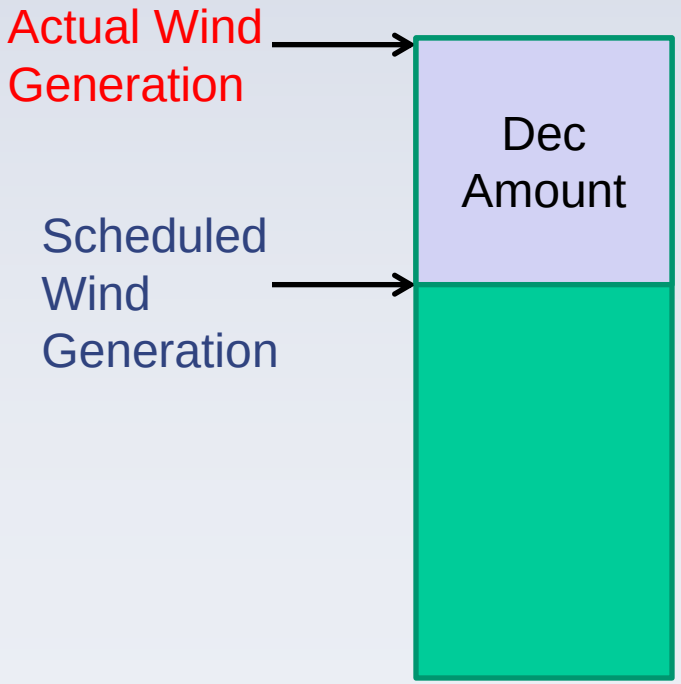
What are Balancing Reserves?

Balancing reserves can be classified into 2 categories: Incremental (Inc) and Decremental (Dec)

Inc Reserves



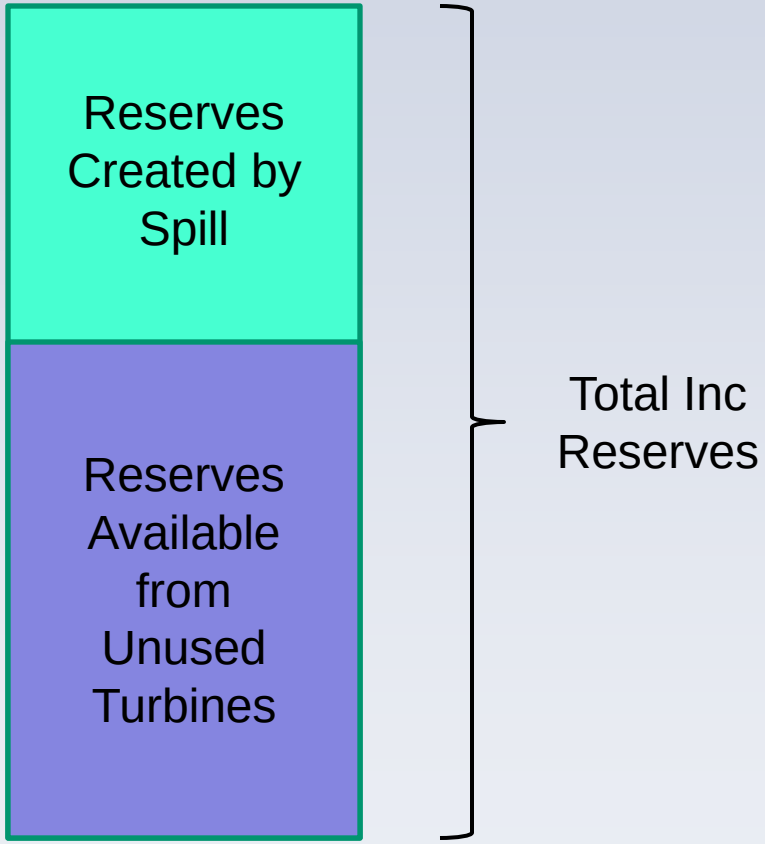
Dec Reserves



Overview of the Analysis

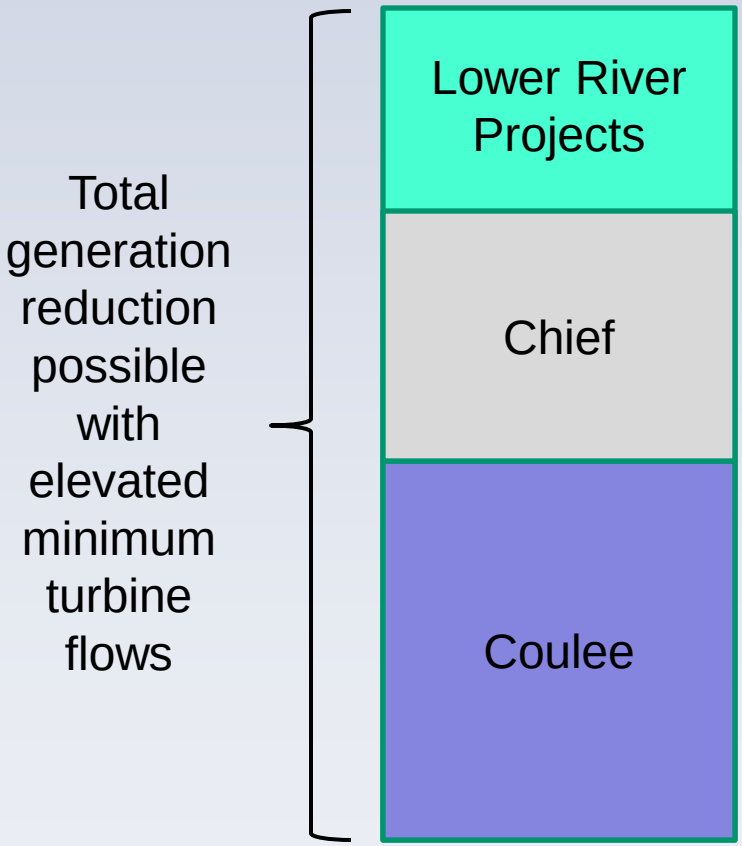
- Both Inc and Dec reserves were analyzed
- A set amount of Inc and Dec reserves were used
  - 900 MW for Inc
  - 1100 for Dec
  - These levels are being used in the current Rate Case
- The idea is to see how the different studies change the ability to carry reserves

Overview of the Analysis – Inc Reserves



- If the Total Inc reserves are less than 900 MW in a given water year/period, it is considered a miss

Overview of the Analysis – Dec Reserves



- For this analysis, elevated minimum turbine flows (above the absolute minimum) created 1100 MW of possible generation reduction
- If the new minimum turbine flow at a project are above those in a given water year/period of a study it is considered a Dec reserve miss

Metrics/Evaluation Criteria

- Each study is run through both the Inc and Dec process
- For each period, the number of water years that can't carry the reserves are recorded as is the magnitude of the reserve miss
- The idea is to see how the different studies limit the ability to carry reserves

Alternative Studies Analysis Results Inc Reserves

Inc Reserve Impacts

	October	November	December	January	February	March	April I	April II	May	June	July	August I	August II	September
Years out of 70 Unable to Carry 900 MW Inc Reserves														
2RC-CC	0	0	0	0	0	0	0	3	4	4	0	0	0	0
2A-TC	0	0	0	0	0	0	0	4	4	6	0	0	0	0
2A-TT	0	0	0	0	0	0	0	5	3	8	0	0	0	0
2B-TC	0	0	0	0	0	0	0	5	5	13	0	0	0	0

	Oct	Nov	Dec	Jan	Feb	Mar	AprI	AprII	May	Jun	Jul	AugI	AugII	Sep
Magnitude of Reserve Miss (MW)														
2RC-CC	0	0	0	0	0	0	0	451	178	574	0	0	0	0
2A-TC	0	0	0	0	0	0	0	341	187	412	0	0	0	0
2A-TT	0	0	0	0	0	0	0	275	197	347	0	0	0	0
2B-TC	0	0	0	0	0	0	0	324	246	429	0	0	0	0

- There were no issues carrying Inc reserves outside of the Spring runoff period
- 2B-TC had the most Inc misses out of any study due to the higher flows

Alternative Studies Analysis Results Dec Reserves

Dec Reserve Impacts

	October	November	December	January	February	March	April I	April II	May	June	July	August I	August II	September
Years out of 70 Unable to Carry 1100 MW Dec Reserves														
2RC-CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A-TC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A-TT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2B-TC	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Oct	Nov	Dec	Jan	Feb	Mar	AprI	AprII	May	Jun	Jul	AugI	AugII	Sep
Magnitude of Reserve Miss (MW)														
2RC-CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A-TC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2A-TT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2B-TC	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- There were no issues carrying 1100 MW of Dec reserves in any of the studies

Component Studies Analysis Results Inc Reserves

Inc Reserve Impacts

	October	November	December	January	February	March	April I	April II	May	June	July	August I	August II	September
Years out of 70 Unable to Carry 900 MW Inc Reserves														
2RC-CC	0	0	0	0	0	0	0	**3**	**4**	**4**	0	0	0	0
E1	0	0	0	0	0	0	0	**7**	**49**	**54**	**1**	0	0	0
E2	0	0	0	0	0	0	0	**13**	**29**	**39**	**5**	0	0	0
E3	0	0	0	0	0	0	0	**2**	**3**	**8**	0	0	0	0
E5	0	0	0	0	0	0	0	**5**	**5**	**13**	0	0	0	0

	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	Aprll	May	Jun	Jul	Augl	Augll	Sep
Magnitude of Reserve Miss (MW)														
2RC-CC	0	0	0	0	0	0	0	**451**	**178**	**574**	0	0	0	0
E1	0	0	0	0	0	0	0	**563**	**775**	**794**	**21**	0	0	0
E2	0	0	0	0	0	0	0	**444**	**750**	**734**	**557**	0	0	0
E3	0	0	0	0	0	0	0	**302**	**269**	**420**	0	0	0	0
E5	0	0	0	0	0	0	0	**324**	**246**	**429**	0	0	0	0

- E1 and E2 showed considerable impacts to the ability to carry 900 MW of Inc reserves, due mainly to high flows and higher spill requirements
  - In E1 and E2 about 15% of the desired reserve level could be carried in the years that miss (about **43-77%** of the years) during May and June
  - In 2RC-CC about 36% of the desired reserve level could be carried in the years that miss (about **6%** of the years) during June

Component Studies Analysis Results Dec Reserves

Dec Reserve Impacts	October	November	December	January	February	March	April I	April II	May	June	July	August I	August II	September
Years out of 70 Unable to Carry 1100 MW Dec Reserves														
2RC-CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E1	0	**21**	**14**	**27**	**20**	0	0	0	0	0	0	0	0	0
E2	0	**17**	**4**	**32**	**12**	0	0	0	0	0	0	0	0	0
E3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Oct	Nov	Dec	Jan	Feb	Mar	AprI	AprII	May	Jun	Jul	AugI	AugII	Sep
Magnitude of Reserve Miss (MW)														
2RC-CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E1	0	**395**	**220**	**268**	**246**	0	0	0	0	0	0	0	0	0
E2	0	**430**	**191**	**378**	**317**	0	0	0	0	0	0	0	0	0
E3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- E1 and E2 are the only studies that had issues maintaining 1100 MW of Dec reserves
  - This is due to the low flows on the river during the Nov – Feb period
  - The minimum flows needed to maintain sufficient Dec reserves were above those found in E1 and E2

Summary

- E1 and E2 Components showed significant impact to the ability to carry both Inc and Dec reserves

  This is a result of low winter flows and high spring flows with elevated spill requirements

- 2B-TC and E5 (as its based on 2B-TC) also showed a decreased ability to carry Inc reserves

  Higher spring flows due to modified upper rule curves was the main driver

Summary (cont.)

- Consequences of reduced ability to carry reserves
  - Additional generation resources would be required to cover Inc reserves for variable resources like wind
  - Variable resources like wind would be forced to lower generation to its schedule
- These studies are done on a monthly time step which is likely a conservative look at reserve impacts
  - Within month flow variation, daily load shape (lack of market spill), and unplanned outages cannot be properly analyzed when looking at monthly data